DOCUMENT RESUME

ED 220 032 HE 015 391

AUTHOR Dean, Robert L.
TITLE The Selection of Hospitals "Comparable" to a University-Owned Teaching Hospital: An Empirical Approach. AIR Forum 1982 Paper.
PUB DATE 18 May 82
NOTE 34p.; Paper presented at the Annual Forum of the Association for Institutional Research (22nd, Denver, CO, May 16-19, 1982).

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Classification; *Comparative Analysis; Discriminant Analysis; Higher Education; *Hospitals; *Institutional Characteristics; *Medical Services; Multivariate Analysis; Research Methodology; Statistical Analysis; *Teaching Hospitals
IDENTIFIERS *AIR Forum

ABSTRACT

A technique for classifying hospitals on a multidimensional basis was developed. Three major sets of attributes were examined: patient case mix, facility mix, and personnel mix. Using multivariate techniques (factor analysis, cluster analysis, and discriminant analysis), 83 variables were examined for 547 hospitals. A total of six factors were identified as useful in grouping comparable hospitals: extended and special services, psychiatric services, radiological services, rehabilitation services, drug dependency services, and pediatric services. The study population included 18 university-owned teaching hospitals and 529 nonuniversity-owned hospitals in 16 western and southeastern states. Through the application of cluster analysis and discriminant analysis, 6 clusters of hospitals were identified, and clusters ranged in size from 10 to 241. University-owned teaching hospitals tended to cluster together in two of the six clusters, providing a basis for comparing to nonuniversity-owned hospitals. The selected hospitals were comparable to Kentucky's two university-owned teaching hospitals: the University of Kentucky and the University of Louisville teaching hospitals. Further analyses will be conducted to examine income and expenditure data of the comparison groups of hospitals in an effort to determine the adequacy of current levels of funding to Kentucky's two teaching hospitals. A list of the 83 study variables and a list of university-owned teaching hospitals and comparable nonuniversity-owned hospitals are appended. (SW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

18E(2)

9

ED220032

THE SELECTION OF HOSPITALS "COMPARABLE" TO A UNIVERSITY-OWNED TEACHING HOSPITAL: AN EMPIRICAL APPROACH

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Association for Institutional Research

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

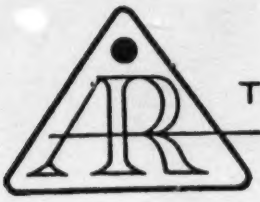
☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Robert L. Dean
Associate Director
Kentucky Council on Higher Education
Frankfort, Kentucky 40601
(502) 564-3576

Paper presented at the Twenty-Second Annual Forum of the Association for Institutional Research (May 18, 1982) in Denver, Colorado.

HE 015 391



THE ASSOCIATION FOR INSTITUTIONAL RESEARCH

This paper was presented at the Twenty-Second Annual Forum of the Association for Institutional Research held at the Denver Hilton Hotel in Denver, Colorado, May 16-19, 1982. This paper was reviewed by the AIR Forum Publications Committee and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC Collection of Forum papers.

D. R. Coleman, Chairman
Forum Publication
Advisory Committee

ABSTRACT

The purpose of this study was to develop and apply a logical technique for classifying hospitals on a multidimensional basis. Three major sets of attributes were examined: patient case mix, facility mix, and personnel mix.

Using multivariate techniques (factor analysis, cluster analysis, and discriminant analysis), 83 variables were examined for 547 hospitals. A total of six factors were identified as useful in grouping comparable hospitals. They were:

1. Extended and Special Services
2. Psychiatric Services
3. Radiological Services
4. Rehabilitation Services
5. Drug Dependency Services
6. Pediatric Services

Applying the factor scores to a cluster analysis technique produced six clusters of hospitals; clusters ranged in size from 10 to 241. University-owned teaching hospitals (UOTH) tended to cluster together in two of the six clusters, providing a basis for comparing UOTH to nonuniversity-owned hospitals (NON-UOH). The study population included 18 UOTH and 529 NON-UOH in sixteen eastern and southeastern states.

INTRODUCTION

It should come as no surprise to administrators of university-owned teaching hospitals that one perception held by the general public of these hospitals is that they are tertiary care facilities which provide treatment of the critically ill and which provide patient services to the poor, often at no cost. Further, a perception persists that these hospitals are largely supported by state and local government appropriations, as well as philanthropy. Recently, these perceptions appear to have influenced legislators, who are advocating consumer choice and price competition as a means to control escalating hospital costs.

For state-level higher education agencies charged with development and administration of funding policy, university-owned teaching hospitals present a dilemma. On the one hand, the hospital is an academic support unit of health related fields of study and also a major research center of health affairs. On the other hand, the hospital serves as a public service center which treats both paying and non-paying patients. It is this last function that seems to cause the greatest financial concern. Universities with teaching hospitals are finding that enrollment-driven funding models provide insufficient financial resources to adequately fund the teaching hospital functions.

The question of whose responsibility it is to treat the indigent patient is a widely discussed and controversial topic. As the cost of providing medical care continues its upward spiral and as financial resources to support teaching hospitals begin to dwindle, university administrators and state officials are faced with the hard decisions of how to continue operation of teaching hospitals without jeopardizing the whole of the higher education enterprise. Although once considered a major asset to the university community, as the relationship between the nation's 126 medical schools and the 64

university-owned teaching hospitals and the federal government has cooled financially, many universities have realized the liabilities they are left with in continued operation of medical programs and the supporting services of the teaching hospitals.

In an attempt to examine the adequacy with which Kentucky supports its two university-owned teaching hospitals, this study was undertaken. Before financial data for similar hospitals could be examined, the concept of comparability had to be clarified. In addition, any meaningful analysis would require access to a sufficiently large data base.

LITERATURE REVIEW

Classification of Institutions

A review of the literature reveals that institutional comparisons and modeling were not new to higher education. For a number of years, researchers in higher education have sought the ideal methodology for classification of institutions. Such classifications are useful for descriptive, comparative, and analytical purposes, and a number of such schemes have been developed over the years. For example, Astin (1962) applied factor analysis to 33 major attributes of colleges using a sample of 335 institutions to develop a set of six dimensions along which institutions differed. Using this scheme, he showed how factor scores could be projected in a two-dimension plane to show relative similarities and differences between universities.

Feldman (1972) described four approaches which had been applied to the classification of institutions of higher education. These were: 1) anthropological vignettes, 2) conventional or nominal schemes, 3) demographical, ecological, and related institutional traits, and 4) institutional climates.

The Carnegie Commission on Higher Education (1973, 1976) typology considers a number of characteristics of higher education institutions in its classification scheme. The Commission began classification of institutions of higher education in 1970 in order to examine more closely the dynamics of institutional life. A revision of the 1973 classification scheme was introduced in 1976 and incorporated 18 institutional categories. The new scheme allowed for more specificity in institution selection and resulted in more accurately reported data useful in institutional comparisons.

Pace (1974) applied an environment assessment questionnaire, called College and University Environment Scales (CUES), to classify eight types of colleges and universities. CUES obtains a series of five scores, each based on 20 statements that define a broad characteristic or attribute of the environment. These five score areas are: Scholarship, Awareness, Community, Propriety, and Practicality. The instrument is intended to measure "the collective perception, the commonly shared beliefs, about the environment held by those who live in and are part of the environment."

Terenzini, Hartmark, Lorang, and Shirley (1980) report the development of a statistical methodology as an alternative to conventional institutional classification structures. According to Terenzini et al. (1980), existing models tend to all share limitations of arbitrariness, a prior specification of the classification structure, and the inability to accommodate more than a limited number of classification criteria. Using this new approach, Terenzini et al. (1980) developed eight homogeneous groups of institutions from the population of all doctoral degree-granting institutions in the American Association of University Professors (AAUP) "Category I."

Smart, Elton, and Martin (1980) attempted to avoid the influence of institutional size, which they viewed to be a limitation of previous studies, and concentrated on

measures used by Cartter and by Roose and Anderson, which directly addressed the concept of institutional quality and prestige. A total of seventeen variables were examined. Of these, six were determined to be independent and usable in developing a spatial configuration analysis to examine the relative similarity of all possible pairs of universities for which complete data were available (n = 63).

Elsass and Lingenfelter (1981) took exception to the use of quality and prestige variables in institutional comparisons. According to Elsass et al. (1981), while such "variables may be useful in the process of separating institutions into similar qualitative groups, few would agree that they are adequate measures of institutional quality." Using the methodology identified by Terenzini et al. (1980), Elsass et al. (1981) examined 26 institutional variables in an effort to identify groups of peer institutions. These variables reported institutional characteristics such as size, program complexity, admissions selectivity, and external research support. The result of this study lead the Illinois Board of Higher Education to the use of a new set of peer group institutions for comparisons in the development of planning and budget recommendations.

Classification of Medical Schools and Hospitals

A number of attempts have been made at grouping medical schools for comparison purposes. The Rand Corporation (Keeler, Koehler, Lee, and Williams, 1972), using factor analysis and cluster analysis techniques, examined 94 medical schools. Using the same technique, Nunn and Lain (1976) examined 23 of the 31 variables from the Rand Study in 99 schools.

McShane (1977) attempted to classify medical schools by examining multiple institutional characteristics maintained by the American Association of Medical Colleges

(AAMC) in their Institutional Profile System (IPS). He began with over 8,000 data elements and reduced this to 140 variables in four categories of measure: 1) institutional, 2) student, 3) faculty, and 4) curriculum. Through a series of correlation studies, the total set of variables was first reduced to 33, and then later through factor analysis, to eight factors. Factor scores for 110 medical schools were computed and schools were then clustered using Ward's (1963) hierarchical technique. Output from the Ward technique was input to a non-hierarchical cluster analysis to refine the final grouping of schools. The final solution of eight clusters based on six factor scores revealed a distinctive pattern: five clusters were completely or predominately public schools; of the other three clusters, two were predominately private, while one was an equal mix of public and private schools.

Although examples of classification techniques were found for grouping institutions and medical schools, few examples could be found which sought to group hospitals on other than an a priori basis. For example, the American Hospital Association (1980) classified hospitals as Community hospitals and as Noncommunity hospitals, with further detail available as to control, term (long and short), service, and size.

Most hospital studies of a decade or so ago examined structural (Carroll, 1969), organizational, or administrative characteristics (Tucker, 1970 and Brown, 1970) in teaching hospitals. Few studies at that time sought to separate teaching hospitals from other hospitals, or to group hospitals for the purpose of comparison.

In the early-to-mid-1970's, a few studies began to appear which focused on identification of differences between hospitals, although these were usually disguised as cost studies of teaching and non-teaching hospitals. From such reports, it became apparent that teaching costs were, in fact, an important ingredient in the difference in

total hospital expenditures between teaching and non-teaching hospitals. However, other quantifiable factors useful in classification were seldom examined. Such an example is a study by Busby, Leming, and Olson (1972) which attempted to compare hospital costs between teaching and comparable non-teaching hospitals in five areas: indigent patient load, ambulatory care, occupancy rate, diagnostic services, and nursing services. Although a stated purpose of the study was to examine costs between comparable hospitals, "the University of Kansas Medical Center's hospital and clinics were considered representative of teaching hospitals, and three community hospitals were considered to be representative of non-teaching hospitals." This is an example of the use of an a priori specification of a classification scheme which appears to have little validity, and which does little to advance the capability of grouping hospitals in a meaningful fashion.

Martz (1978), for example, showed that service charges on teaching floors were 60 percent higher than on non-teaching floors. Increased volume of workups and treatment for hospitalized patients that were ordered by residents appeared to be the major reasons for higher charges. Because the Martz study was conducted within one hospital, it did not attempt to group hospitals for comparison purposes, but did attempt to show that major differences exist between charges in teaching and non-teaching hospitals.

More recently, Butler, Bentley, and Knapp (1980) attempted to examine the characteristics which distinguished teaching from non-teaching hospitals. A total of 13 characteristics were identified which, according to Butler et al. (1980), "provides a framework for systematically examining variations among teaching hospitals." The study points out that there are many variations among and between teaching and non-teaching hospitals and concludes that because of the complexity of the operating environment in which teaching hospitals operate, it is "urgent for teaching hospitals to examine and explain, quantitatively and subjectively, what they do and how they differ" from other hospitals.

One characteristic identified by Butler et al. (1980) was the patient case mix in teaching hospitals. Ament, Kobrinski, and Wood (1981) recently examined case mix complexity in 200 short-term general hospitals in three categories: major teaching, other teaching, and nonteaching. It was concluded that teaching hospitals could be expected to cost somewhat more per patient, even if case mix were the only factor considered. Ament et al. (1981) found that cost differences between teaching and non-teaching hospitals ranged from $100 to $180 per patient case. Thus the extra expense burden for a medium-sized teaching hospital due to its more complex case mix is likely to exceed $1,000,000 per year. Again, and as with other studies, although Ament et al. (1981) did an excellent job of examining costs and patient case mix, the study seemed to leave unanswered the question regarding comparability.

THE PRESENT STUDY

Purpose

The purpose of this research was to develop and apply a technique which would identify a group or groups of hospitals comparable to Kentucky's two university-owned teaching hospitals: the University of Kentucky and the University of Louisville teaching hospitals. Once comparable hospitals were identified, further analyses will be conducted to examine income and expenditure data of the comparison group(s) of hospitals in an effort to determine the adequacy of current levels of funding to Kentucky's two teaching hospitals. The study reported here presents the results of the efforts in developing and applying a technique to the identification of hospitals comparable to the University of Kentucky and University of Louisville teaching hospitals.

Because the administrative purpose of this project was to compare Kentucky's two university-owned teaching hospitals to other comparable university-owned teaching hospitals (UOTH) and to other comparable nonuniversity-owned hospitals (NON-UOH), the

major thrust of the study is in the identification of these hospitals. Other noncomparable hospitals were considered only with passing interest, although they were identified in the group or cluster they were determined to be most like.

Data Source

Data used in the study were provided by the American Hospital Association's 1979 Annual Survey of Hospitals (data tape); these data cover the period October 1, 1978 to September 30, 1979 (the latest available data).

From a total population of 6,988 hospitals, a stratified sample population was selected for detailed analysis. The criteria used for inclusion of a hospital in the sample population were that the hospital must be:

A. Located in one of the sixteen eastern or southeastern states (states included were: Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Kentucky, Maryland, Missouri, North Carolina, Ohio, South Carolina, Tennessee, Texas, Virginia, and West Virginia);

B. Bedsize $\geq$ 200;

C. Short-term hospital;

D. General medical and surgical hospital;

E. Not federal government controlled;

F. Reporting data on all variables.

A total of 547 hospitals met these criteria.

METHOD

On the basis of a review of the literature concerning hospitals, universities, and businesses in general, it was determined that the best approach would be to examine multiple hospital characteristics simultaneously. Thus, three major sets of hospital characteristics were identified as potentially helpful for classification purposes. They were: patient case mix characteristics, facilities mix characteristics, and personnel mix characteristics. In total, 83 variables were initially examined (See Table 1); of that number, 53 were facility mix variables, 24 were patient case mix variables, and six were personnel mix variables.

A three step statistical approach, similar to that identified by Terenzini et al. (1980), was applied to the sets of variables. The first step, following the identification of appropriate variables, was to submit these variables to Factor Analysis. The result of the factor analysis is a reduction of a large group of variables into a small number of factors which convey the essential information contained in the large group of variables. Factor scores for each observation (hospital) were developed and served as input to the second analytical step, cluster analysis.

The Cluster Analysis step involves the statistical grouping of a large number of observations (hospitals) on the basis of measures of similarity or dissimilarity as reflected by the individual (hospital) factor scores. The result of this step, which is based on an algorithm of hierarchical clustering, is a series of grouped observations (hospitals). Because the user of the clustering technique must specify an optimal number of clusters from the various patterns which emerge during the clustering process, the third step of applying discriminant analysis to the classification of observations (hospitals) becomes an important step.

Discriminant Analysis provides the user the ability to examine previously established groupings of observations and test for proper grouping. The basic model used, also known as a classification criterion, is determined by a measure of generalized squared distance. The technique uses the values of a classification variable to distinguish the groups for the analysis. In this study, factors used in cluster analysis are entered into discriminant analysis where their relative importance in explaining cluster separation is determined. Group means were calculated for factors found to be important (called discriminant functions) and these groups are mapped into space. Factor scores for individual hospitals are then compared to the location of their cluster means. The use of this third step determines if all observations (hospitals) have been properly clustered, and if they have not, specifies the cluster into which they should be fit.

Results of Factor Analysis

Before beginning the factor analysis step, Pearson product-moment correlations of the 83 variables were examined. From the correlation matrix it was determined that 44 variables were relatively independent and should be included in the factor analysis.

Table 2 shows the 44 variables representing patient case mix, facility mix, and personnel mix which were entered into factor analysis (FACTOR procedure -- SAS, 1979) using the iterated principal axis technique. From the analysis, six factors were identified as having eigen valves greater than one; this number also corresponded to that determined by applying the scree test, as suggested by Cattell (1966). The six factors were then rotated orthogonally using Kaiser's varimax criterion, which is now generally accepted as the best analytic orthogonal rotation technique (Rummel, 1970). Orthogonal rotation was achieved in order to develop a set of uncorrelated and linearly independent factor scores. Table 3 shows the varimax rotated factor loading pattern of these six factors. These factors accounted for 79.6 percent of the variance among the 44 hospital variables used in this study.

The variables with the strongest loadings on Factor One were two personnel mix variables: Medical and Dental Residents, and Trainees. Other strong loading variables were chiefly facility mix variables: Genetic Counseling Service and Burn Care Unit, followed by Family Planning Service, Psychiatric Outpatient Service, Burn Care and Organ Bank. Because of the wide range of services appearing in Factor One, it was named "Extended and Special Services."

The strongest loading variable in Factor Two was Psychiatric Inpatient Unit (a facility mix variable). Because all but one variable (Clinic Psychology Service) which strongly loaded on this factor related to psychiatric facilities, services, and patients, Factor Two was named "Psychiatric Service."

Factor Three had as its heaviest loading variables those related to radiation treatment. Thus, this factor was identified as "Radiological Services." Factor Four loaded equally (.82) on Rehabilitation Inpatient Unit and Rehabilation Care and was identified as "Rehabilitation Services."

Likewise, all variables loading heavily on Factor Five were alcoholism and chemical dependency-related; Factor Five was named "Drug Dependency Services."

Factor Six had as its heaviest loading the patient mix variable Pediatric Intensive Care, followed by Pediatric Inpatient Unit, Obstetric Care, Premature Nursery and, Neonatal Intensive Care Unit. This factor was identified as "Pediatric Services."

Standard factor scores were next calculated using the regression method of computation for each of the 547 hospitals in the study population; factor scores were then input to the cluster analysis procedures.

Results of Cluster Analysis

In cluster analysis, using an algorithm outlined by Johnson (1967), the CLUST procedure (SAS, 1979) begins by forming one cluster for each observation in the analysis. The two closest clusters are combined into one cluster, then the two closest of the new set of clusters are combined into a single cluster, and so on. Using previously calculated factors scores -- one for each factor for each hospital -- the cluster procedure was utilized to identify six clusters of hospitals.

An examination of this six cluster solution revealed that it might be advantagous to examine a five cluster solution , since the ratio of "Number of Distances Within $\leq$ Maximum" and "Number of Distances in All $\leq$ Maximum" showed a significant shift between five and six clusters of hospitals. Interestingly, the membership in the last four clusters in both solutions was identical. Stated another way, the five cluster solution combined clusters one and two of the six cluster solution but left unaltered the membership of the last four clusters (See Table 4).

Because the selection of an optimal number of clusters is subjective and difficult, results of the cluster procedures served as input to the discriminant analysis step in order to test for classification or proper grouping.

Results of the Discriminant Analysis

The primary purpose of applying the discriminant analysis technique in this study was to determine how well hospitals had been grouped with the cluster analysis procedure. The DISCRIM procedure (SAS, 1979) develops a discriminant model that it uses to classify each observation into one of the groups, and then it summarizes the performance of this discriminant model.

The model, also known as a classification criteria, is determined by a measure of generalized squared distance. Table 5 shows the results of the classification analysis. Results of the classification appear satisfactory, although one small cluster (Cluster Three) did have a lower than desired number of hospitals properly classified.

Discussion of Results

The purpose of this study, which was to group hospitals on the basis of similarity with regard to patient case mix, facility mix, and personnel mix, was achieved. An examination of cluster membership shows that 13 of the 18 university-owned teaching hospitals (UOTH) in the study were grouped into Cluster Five, with the remaining five UOTH grouped into Cluster Two. Thus, the method appears to have achieved the goal by grouping UOTH and provides the means for further analysis, comparison, and study of comparable UOTH and nonuniversity-owned hospitals (NON-UOH).

Table 6 presents a comparison of hospital attributes in each cluster. This table presents the comparative Service Factor descriptors for each group of hospitals based on interpretation of group mean factor scores, and allows narrative statements to be made concerning the relative levels of service in each group. As can be seen, each of the six clusters in the final solution has a unique profile. An examination of this table reveals that the distinguishing characteristic of Cluster Five (which contains the majority of the UOTH) is its very high level of Extended and Special Services, which is to say that 15 of the 18 UOTH likewise possess this characteristic.

A closer examination of Clusters Two and Five in Table 7 shows how UOTH differ between the two clusters, and further, how UOTH differ from NON-UOH within each cluster. For example, the major differences between the UOTH in Cluster Two and Cluster Five relate to differences in Rehabilitation Care, Orthopedic Care, Other Specified Care, and particularly the percent of Medical and Dental Residents, and

Trainees. What is clear from Table 7 is that although mean factor scores are useful in understanding the general characteristics of a given cluster, there remains considerable variation even between hospitals within the same cluster.

For hospital comparisons, two approaches could be taken. The first is to compare all UOTH to all NON-UOH within the same cluster. However, because such comparisons necessarily cross boundaries established by economic, social, and political considerations, Kentucky has elected to restrict comparisons to hospitals in the same cluster and within the same geographic area. For this study, within-cluster examination selected UOTH and NON-UOH which operate in the same city, or same state (if no comparable hospital was found within the same city).

Table 8 shows the result of the construction of this list of comparable hospitals. In the event no comparable NON-UOH was found within the same state, neither the UOTH nor other NON-UOH is shown. What results, then, is a refined and highly selected list of comparable UOTH and NON-UOH which operate in the same city or state. A preliminary examination of hospital expenditures between comparable hospitals (those within the same cluster) revealed a significant difference -- a portion of which was likely due to a differing socio-economic-political operating environment.

SUMMARY

The purpose of this study was to develop and apply a logical technique for identifying hospitals which were comparable. Three bases for this comparison were selected: facilities mix, patient case mix, and personnel mix. Multivariate statistical techniques were applied to 83 variables in an effort to isolate factors useful for hospital grouping. Those factors identified were: 1) Extended and Special Services, 2) Psychiatric

Services, 3) Radiological Services, 4) Rehabilitation Services, 5) Drug Dependency Services, and 6) Pediatric Services. These six factors accounted for nearly 80 percent of the variance among the variables examined.

The study population included 18 university-owned teaching hospitals (UOTH) and 529 nonuniversity-owned hospitals (NON-UOH). Through the application of cluster analysis and discriminant analysis, six clusters of hospitals were identified.

The decision about how to compare hospitals, medical schools or institutions is ultimately subjective. This study attempted to minimize subjectivity where possible by dealing with comparison criteria from a multidimensional aspect. Still, subjectivity may influence these criteria, and future studies should attempt to minimize such subjectivity. In addition, the availability of more recent data would be advantageous, especially in the event of hospitals undergoing significant changes as was the case with the University of Louisville teaching hospital in 1978-79.

Although the results of this study were satisfactory for establishing an initial set of comparable hospitals for further study, no peer-set should be considered final. A repeat of this study should be undertaken periodically, perhaps every two years, in an effort to deal with the dynamics of the hospital operating environments.

Further, and particularly for the purpose of examining differences between UOTH and NON-UOH, consideration may need to be given to the presence of teaching programs or other forms of hospital affiliation with medical schools. Although there are 64 UOTH in the United States, there are between 75 and 100 other hospitals which might be classified as principle sites of clinical education. Another 400 belong to the Association

of American Medical Colleges' (AAMC's) Council of Teaching Hospitals (COTH). Over 1,000 hospitals are affiliated with a medical school, and nearly 1,300 or 18 percent of the nation's hospitals participate in at least one residency program (Association of American Medical Colleges, 1981). Analysis of such associations may help to further explain hospital differences and similarities.

Bibliography

Ament, R.P., Kobrinski, E.J., and Wood, W.R., Case mix complexity differences between teaching and nonteaching hospitals. Journal of Medical Education, 1981, 56, 874-903.

American Hospital Association, Hospitals Statistics (1980 Edition) Chicago, Illinois: American Hospital Association, 1980.

Association of American Medical Colleges, Toward a more contemporary public understanding of the teaching hospital, Washington, D.C.: Department of Teaching Hospitals, 1981.

Astin, Alexander W., An empirical characterization of higher education institutions, Journal of Education Psychology, 1962, 53, No. 5, 224-235.

Brown, B., Jr., Teaching hospital organizational identify and climate inventory. Unpublished doctoral dissertation, Marquette University, 1970.

Busby, D.D., Leming, J.C., and Olson, M.I., Unidentified educational costs in a university teaching hospital: an initial study. Journal of Medical Education, 1972, 47, 243-253.

Butler, P.W., Bentley, J.D., and Knapp, R.M., Today's teaching hospitals: old sterotypes and new realities. Annuals of Internal Medicine, 1980, 93, 614-618.

Carnegie Commission on Higher Education, A classification of institutions of higher education, Berkley, California: Carnegie Commission on Higher Education, 1973.

Carnegie Commission on Higher Education, A classification of institutions of higher education: revised edition", Berkley, California: Carnegie Commission on Higher Education, 1976.

Cattell, R.B., The scree test for the number of factors. Multivariate Behavioral Research, 1966, 1, 245-276.

Carroll, J., The structure of teaching hospitals. Unpublished doctoral dissertation, University of Chicago, 1969.

Elsass, J.E. and Lingenfelter, P.E., An identification of college and university peer groups, Springfield, Illinois: Illinois Board of Higher Education, 1981 (Mimeo).

Feldman, K.W. (Ed.), College and Student, New York: Pergamon, 1972.

Johnson, S.C., Hierarchial clustering schemes. Psychametrika, 1967, XXXII, 241-254.

Keeler, E., Kochler, J.E., Lee, C., and Williams, Jr., A.P., Finding representative academic health centers", working paper prepared for NIH/DHEW, Santa Monica, California: The Rand Corporation, 1972.

Martz, E.W., Educational costs to hospitalized patients. Journal of Medical Education, 1978, 53, No. 5, 383-386.

McShane, M.G., An empirical classification of U.S. medical schools by institutional dimensions, Washington, D.C.: American Association of Medical Colleges, 1977.

Nunn, R. and Lain, L.L., Classification of medical institutions, Washington, D.C.: American Association of Medical Colleges, 1976.

Pace, C. Robert, The demise of diversity: a comparative profile of eight types of institutions, a technical report sponsored by the Carnegie Commission on Higher Education, Berkley, California, 1974.

Rummel, R.J., Applied Factor Analysis. Evanston: Northwestern University Press, 1970.

SAS Institute, Inc., Statistical Analysis System. Cary, North Carolina, 1979.

Smart, J.C., Elton, C.F., Martin, R.O., Quanlitative and conventional indices of benchmark institutions, Proceedings, Association for Institutional Research, Atlanta, Georgia, p. 73 (abstract), 1980.

Terenzini, P.T., Hartmark, L., Lorang, W.C., and Shirley, R.C., A conceptual and methodological approach to the identification of peer institutions. Research in Higher Education, 12, No. 4, 1980, 347-364.

Tucker, S.L., A comparison of major teaching hospitals and other community general hospitals in terms of characteristics and activities of organization and administration. Unpublished doctoral dissertation, George Washington University, 1970.

Ward, Joe H., Hierarchical grouping to optimize an objective function, American Statistical Association Journal, 1963, 58, 236-244.

TABLES

TABLE I

Variables Examined
(n = 83)

PATIENT CASE MIX VARIABLES

1. Percent Outpatient Surgery of Total Surgical Operations
2. Percent Emergency Visits to Total Outpatient Visits
3. Percent Inpatient Surgery to Total Surgical Operations
4. Percent Adult Inpatient Days in General Medical/Surgical Unit to Total Inpatient Days
5. Percent Pediatric Inpatient Days in General Medical/Surgical Unit to Total Inpatient Days
6. Percent Pediatric Inpatient Days in Pediatric Intensive Care Unit to Total Inpatient Days
7. Percent Neonatal Inpatient Days in Neonatal Intensive Care Unit to Total Inpatient Days
8. Percent Neonatal Inpatient Days in Neonatal Intermediate Care Unit to Total Inpatient Days
9. Percent Inpatient Days in Cardiac Intensive Care Unit to Total Inpatient Days
10. Percent Inpatient Days in Mixed or Other Intensive Care Unit to Total Inpatient Days
11. Percent Inpatient Days in Burn Care Unit to Total Inpatient Days
12. Percent Inpatient Days in Obstetric Unit to Total Inpatient Days
13. Percent Inpatient Days in Self-Care Unit to Total Inpatient Days
14. Percent Inpatient Days in Long-Term Skilled Nursing Unit to Total Inpatient Days
15. Percent Inpatient Days in Other Long-Term Unit to Total Inpatient Days
16. Percent Inpatient Days in Psychiatric Inpatient Unit to Total Inpatient Days
17. Percent Inpatient Days in Mental Retardation Unit to Total Inpatient Days
18. Percent Inpatient Days in Alcoholism/Chemical Dependency Unit to Total Inpatient Days
19. Percent Inpatient Days in Tuberculosis or Other Respiratory Disease Care Unit to Total Inpatient Days
20. Percent Inpatient Days in Eye, Ear, Nose, and Throat Unit to Total Inpatient Days
21. Percent Inpatient Days in Rehabilitation Unit to Total Inpatient Days
22. Percent Inpatient Days in Orthopedic Unit to Total Inpatient Days
23. Percent Inpatient Days in Chronic Disease Unit to Total Inpatient Days
24. Percent Inpatient Days in Other Specified Units to Total Inpatient Days

FACILITY MIX VARIABLES

1 - Postoperative recovery room
2 - Intensive care unit (cardiac care only)
3 - Intensive care unit (mixed)
4 - Open-heart surgery facilities
5 - Pharmacy with FT registered pharmacist
6 - Pharmacy with PT registered pharmacist
7 - X-ray radiation therapy
8 - Megavoltage radiation therapy
9 - Radioactive implants
10 - Diagnostic radioisotope facility
11 - Therapeutic radioisotope facility
12 - Histopathology laboratory
13 - Organ bank
14 - Blood bank
15 - Electroencephalography
16 - Respiratory therapy department
17 - Premature nursery
18 - Self-care unit
19 - Skilled nursing or long-term unit
20 - Hemodialysis (inpatient)
21 - Hemodialysis (outpatient)
22-Burn care unit
23 - Physical therapy department
24 - Occupational therapy department
25 - Rehabilitation inpatient unit
26 - Rehabilitation outpatient unit
27 - Psychiatric inpatient unit
28 - Psychiatric outpatient services
29 - Psychiatric partial hospitalization program
30 - Psychiatric emergency services
31 - Psychiatric foster and/or home care
32 - Psychiatric consultation and educational services
33 - Clinical psychology services
34 - Organized outpatient department
35 - Emergency department
36 - Social work department
37 - Family-planning service
38 - Genetic counseling services
39 - Abortion service (outpatient)
40 - Abortion service (outpatient)
41 - Home care department
42 - Dental services
43 - Podiatric services
44 - Speech pathology services
45 - Hospital auxiliary
46 - Volunteer services department
47 - Patient representative services
48 - Alcoholism/chemical dependency inpatient unit
49 - Alcoholism/chemical dependency outpatient services
50 - TB and other respiratory disease units
51 - Neonatal intensive care unit
52 - Pediatric inpatient unit
53 - CT scanner

PERSONNEL MIX VARIABLES

1. Percent FTE Physicians and Dentists to Total FTE Personnel
2. Percent FTE Registered Nurses to Total FTE Personnel
3. Percent FTE Licensed Practical and Vocational Nurses to Total FTE Personnel
4. Percent FTE Medical and Dental Residents to Total FTE Personnel
5. Percent FTE Trainees to Total FTE Personnel
6. Percent FTE All Other Personnel to Total FTE Personnel

TABLE 2

VARIABLES INCLUDED IN FACTOR ANALYSIS (N = 44)

Facility Mix Variable

1. Open-heart Surgery Facilities
2. X-ray Radiation Therapy
3. Megavolt Radiation Therapy
4. Radioactive Implants
5. Therapeutic Radiosotope Facility
6. Organ Bank
7. Premature Nursery
8. Skilled Nursing or Long-Term Care Unit
9. Hemodialysis (Inpatient) Facility
10. Hemodialysis (Outpatient) Facility
11. Burn Care Unit
12. Occupational Therapy Unit
13. Rehabilitation Inpatient Unit
14. Rehabilitation Outpatient Services
15. Psychiatric Inpatient Unit
16. Psychiatric Outpatient Services
17. Psychiatric Partial Hospitalization
18. Psychiatric Emergency Services
19. Psychiatric Consultation/Education Services
20. Clinical Psychology Services
21. Organized Outpatient Department
22. Family Planning Service
23. Genetic Counseling Service
24. Abortion Service (Inpatient)
25. Abortion Service (Outpatient)
26. Speech Pathology Services
27. Pediatric Inpatient Unit
28. Alcoholism/Chemical Dependency Outpatient Unit
29. Alcoholism/Chemical Dependency Inpatient Services
30. Neonatal Intenstive Care Unit
31. CT Scanner

Patient Mix Variables

1. Emergency visits
2. Pediatric Intensive Care
3. Pediatric General Medical/Surgical Care
4. Neonatal Intensive Care
5. Burn Care
6. Obstetric Care
7. Long-Term Skilled Nursing Care
8. Psychiatric Care
9. Alcoholism/Chemical Dependency Care
10. Rehabilitation Care

Personnel Mix Variables

1. Physicians and Dentists
2. Medical and Dental Residents
3. Trainees

TABLE 3

Varimax Rotated Factor Loadings
(only loadings of .40 or greater are reported)

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor Names
Organ Bank	.40						
Burn Cure Unit	.56						
Psychiatric Outpatient Services	.47						Extended and
Family Planning Services	.49						Special Services
Genetic Counseling Service	.57						
Burn Care (patients)	.44						
Medical and Dental Residents	.78						
Trainees	.76						
Psychiatric Inpatient Unit		.77					
Psychiatric Outpatient Services		.54					
Psychiatric Partial Hospitalization		.49					Psychiatric
Psychiatric Emergency Services		.62					Services
Psychiatric Consultation & Education Services		.56					
Clinical Psychology Services		.52					
Psychiatric Care (patients)		.70					
Open-heart Surgery Facilities			.42				
X-ray Radiation Therapy			.68				
Megavolt Radiation Therapy			.70				
Radioactive Implants			.65				Radiological
Therapeutic Radioisotope Facility			.55				Services
Hemodialysis (Inpatient) Facility			.48				
Hemodialysis (Outpatient) Facility			.43				
CT Scanner			.44				
Rehabilitation Inpatient Unit				.82			Rehabilitation
Rehabilitation Care (patients)				.82			Services
Alcoholism/Chemical Dependency Inpatient Unit					.90		Drug
Alcoholism/Chemical Dependency Outpatient Unit					.59		Dependency
Alcoholism/Chemical Dependency Care (patients)					.83		Services
Premature Nursery						.48	
Neonatal Intensive Care Unit						.41	
Pediatric Inpatient Unit						.64	Pediatric
Pediatric Intensive Care						.66	Services
Obstetric Care						.51	
% Total Variance	37.2	11.3	9.4	8.2	7.2	6.3	79.6
% Common Variance	47.2	14.3	11.5	10.2	9.1	7.6	100

TABLE 4

Six Cluster Solution

Cluster Number	UOTH in Cluster	NON-UOH in Cluster	Total Hospitals in Cluster
1	0	211	211
2	5	236	241
3	0	17	17
4	0	44	44
5	13	11	24
6	0	10	10
Total	18	529	547

Five Cluster Solution

Cluster Number	UOTH in Cluster	NON-UOH in Cluster	Total Hospitals in Cluster
1	5	447	452
2	0	17	17
3	0	44	44
4	13	11	24
5	0	10	10
Total	18	529	547

TABLE 5

Classification Results

Actual Cluster	% Correctly Classified	Classified Cluster 1	2	3	4	5	6
1(n=211)	92.4	195	15	0	0	0	0
2(n=241)	88.4	24	213	0	0	4	0
3(n=17)	58.8	6	0	10	1	0	0
4(n=44)	100.0	0	0	0	44	0	0
5(n=24)	100.0	0	0	0	0	24	0
6(n=10)	100.0	0	0	0	0	0	10
Total		225	228	10	45	29	10
Percent		41.1	41.7	1.8	8.2	8.3	1.8
Priors		38.6	44.1	3.1	8.0	4.3	1.8

TABLE 6

Cluster 2 and Cluster 5 Compared on Relative Levels of Services Provided

Service Factor	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6
1. Extended and Special Services	Low	Moderate	Moderate	Moderate	Very High	Moderate
2. Psychiatric Services	Moderate	Moderate	High	Moderate	Moderate	Moderate
3. Radiological Services	Low	High	High	Moderate	High	Low
4. Rehabilitation Services	Low	Moderate	Moderate	Low	Low	Very High
5. Drug Dependency Services	Low	Low	High	Very High	Moderate	Low
6. Pediatric Services	Moderate	Low	High	Low	Moderate	Low

Rating Scale Used (based on mean group factor scores)

Very Low

Low

Moderate

High

Very High

TABLE 7

A Comparison of Patient Mix and Personnel Mix Characteristics Between Hospitals in Cluster 2 and Cluster 5

	CLUSTER 2		CLUSTER 5	
Patient Mix	UOTH (n=5)	NON-UOH (n=236)	UOTH (n=13)	NON-UOH (n=11)
Pediatric Intensive Care	0.5%	0.1%	1.4%	0.9%
Neonatal Intensive Care	2.2%	0.5%	2.6%	2.5%
Cardiac Intensive Care	1.4%	1.6%	1.3%	1.6%
Mixed/Other Intensive Care	4.6%	3.5%	4.0%	3.2%
Burn Care	0.2%	0.0%	0.7%	0.9%
Obstetric Care	5.0%	4.6%	5.6%	7.8%
Self Care	0.8%	0.0%	0.4%	0.5%
Psychiatric Care	6.7%	3.7%	6.9%	4.1%
Drug Dependency Care	0.0%	0.0%	0.6%	0.2%
Rehabilitation Care	3.5%	0.5%	1.1%	0.1%
Orthopedic Care	0.0%	2.5%	5.3%	4.3%
Other Specified Care	0.9%	0.6%	4.2%	0.8%
Personnel Mix				
Physicians and Dentists	0.4%	0.5%	0.5%	1.9%
Registered Nurses	20.8%	19.9%	22.4%	16.7%
L.P.N. and Vocational Nurses	5.3%	8.6%	6.9%	7.3%
Medical and Dental Residents	2.7%	0.9%	13.2%	9.6%
Trainees	2.9%	1.2%	13.4%	10.1%

TABLE 8

UOTHs and Comparable Non-UOTH

	UOTHs		Comparable Non-UOH
1.	Ohio State University Hospital Columbus, Ohio	1.	Grant Hospital Columbus, Ohio
		2.	Mount Carmel Medical Center Columbus, Ohio
		3.	Mount Carmel East Hospital Columbus, Ohio
2.	Duke University Hospital Durham, North Carolina	1.	Memorial Mission Hospital Asheville, North Carolina
		2.	Cape Fear Valley Hospital Fayetteville, North Carolina
		3.	Wayne County Memorial Hospital Goldsboro, North Carolina
		4.	Moses H. Cone Memorial Hospital Greensboro, North Carolina
		5.	Catawb Memorial Hospital Hickory, North Carolina
		6.	Craven County Hospital New Bern, North Carolina
		7.	Cleveland Memorial Hospital Shelby, North Carolina
		8.	New Hanover Memorial Hospital Wilmington, North Carolina
		9.	Forsyth Memorial Hospital Winston-Salem, North Carolina
3.	Rush-Presbyterian-St. Luke's Hospital Chicago, Illinois	1.	Thorek Hospital Chicago, Illinois
		2.	Augusta Hospital Chicago, Illinois
		3.	Bethany Methodist Hospital Chicago, Illinois
		4.	Edgewater Hospital Chicago, Illinois
		5.	Illinois Masonic Medical Center Chicago, Illinois
		6.	Louis A. Weiss Memorial Hospital Chicago, Illinois
		7.	Michael Reese Hospital Chicago, Illinois
4.	Crawford W. Long Memorial Hospital of Emory University Atlanta, Georgia	1.	Georgia Baptist Hospital Atlanta, Georgia
		2.	Piedmont Hospital Atlanta, Georgia
		3.	St. Joseph's Hospital Atlanta, Georgia

TABLE 8
(continued)

	UOTHs		Comparable Non-UOH
5.	University of Maryland Hospital Baltimore, Maryland	1.	Baltimore City Hospitals Baltimore, Maryland
6.	Talmadge Memorial Hospital Augusta, Georgia	1.	Grady Memorial Hospital Atlanta, Georgia
7.	Medical College of Ohio Hospital Toledo, Ohio	1. 2.	Cuyohoga County Hospitals Cleveland, Ohio Cleveland Clinic Hospital Cleveland, Ohio
8.	University of Illinois Hospital Chicago, Illinois	1. 2.	Northwestern Memorial Hospital Chicago, Illinois Cook County Hospital Chicago, Illinois
9.	University of Texas Medical Branch Galveston, Texas	1.	Bexar County Hospital District San Antonio, Texas
10.	University of Kentucky Hospital Lexington, Kentucky	1. 2. 3. 4. 5. 6. 7.	Jennie Stuart Memorial Hospital Hopkinsville, Kentucky Jewish Hospital Louisville, Kentucky Highland Baptist Hospital Louisville, Kentucky St. Anthony Hospital Louisville, Kentucky Audubon Hospital Louisville, Kentucky Surburban Hospital Louisville, Kentucky St. Mary & Elizabeth Louisville, Kentucky